

Trans-Pacific Demonstrations Overview

JUSTSAP Conference
November 2000

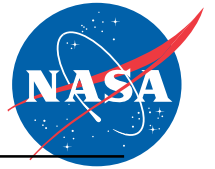
Richard desJardins
NASA Research and Education Network

NASA RESEARCH AND EDUCATION NETWORK

Tomorrow's Networking Applications Today

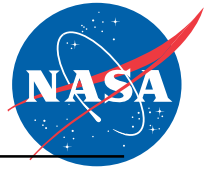


TPD Overview



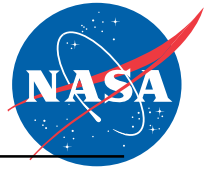
- **Background**
 - Initiated in 1996 by the Japan-U.S. Science, Technology and Space Application Program
 - Experiments were part of the G-7 Nations' Information Society/Global Interoperability for Broadband Networks (GIBN) Project
 - Demonstrated distributed High Definition Video and established first 2-satellite hop broadband ATM infrastructure to conduct digital HDV post-production activities between Tokyo and Los Angeles
- **Purpose of Trans-Pacific Demonstrations**
 - Determine how to incorporate satellite links with fiber optic cables to form high performance global telecommunications networks
 - Demo application of global-scale high performance communications networks in telemedicine and distance education using IP-based technologies
- **TPD Participants**
 - Government, academic and industry teams from Canada, Japan and the U.S.

TPD Network Infrastructure



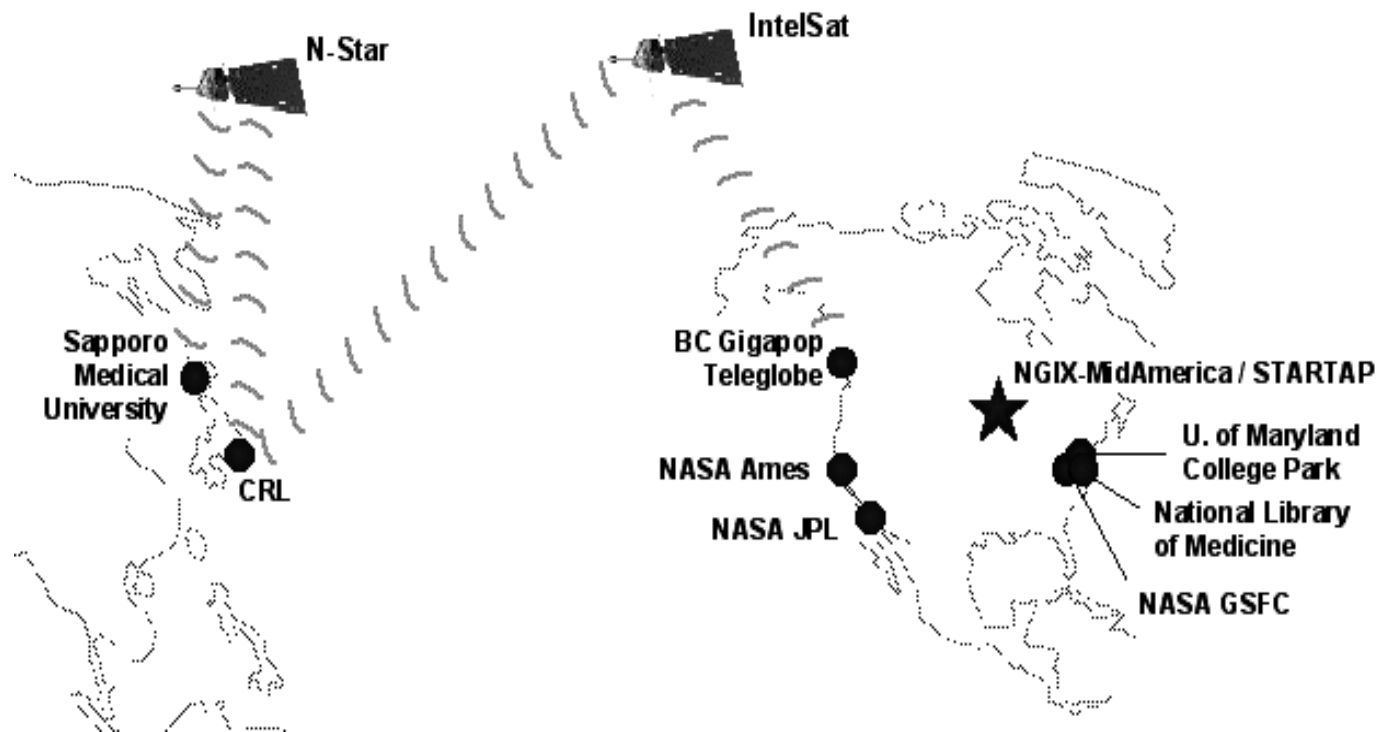
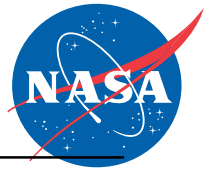
- **Hybrid Network**
 - TPD applications used a combination of terrestrial fiber optic networks and two high data rate geostationary satellites (Intelsat and N-Star): total signal path exceeded 100,000 miles
 - Both satellites operate at both C and Ku band and transmit data at rates up to 155 Mb/s
- **Key points in the Network Infrastructure**
 - NASA Goddard Space Flight Center (Greenbelt, MD) - NREN/HPCC Point of Presence
 - STARTAP (Chicago, IL) - North American Exchange Point
 - Tokyo XP (Tokyo, Japan) - Japan Exchange Point for APAN
 - Lake Cowichan, British Columbia - Satellite Earth Station
 - Kashima Space Research Center (Tokyo, Japan) - Satellite Earth Station
 - BC GigaPOP (Vancouver, British Columbia) - Canada Exchange Point

TPD Network Infrastructure



- **Primary Wide-Area Transit Service**
 - NREN (U.S.)
 - Teleglobe (Canada)
 - AT&T Canada (formerly Metronet)
 - CA*net3 (Canada)
 - APAN/TransPAC (U.S.-Japan)
 - Imnet (Japan)
- **Key Features of Network Architecture**
 - **Parallel paths:**
 - Satellite and terrestrial paths were both available simultaneously
 - When the satellite became temporarily unavailable, traffic automatically redirected to the TransPAC path
 - **SkyX translation:**
 - The SkyX TCP connection enhancement gateway was used for the Visible Human application
 - SkyX replaces TCP with a proprietary protocol optimized for reliable transmission over high bandwidth-delay links such as satellites

TPD Network Infrastructure



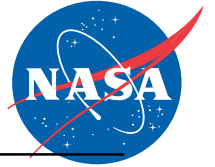
Trans-Pacific High Data Rate Satellite
Communications Infrastructure Diagram

NASA RESEARCH AND EDUCATION NETWORK

Tomorrow's Networking Applications Today

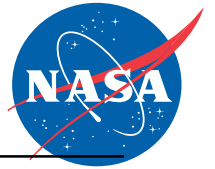


TPD Demonstrations

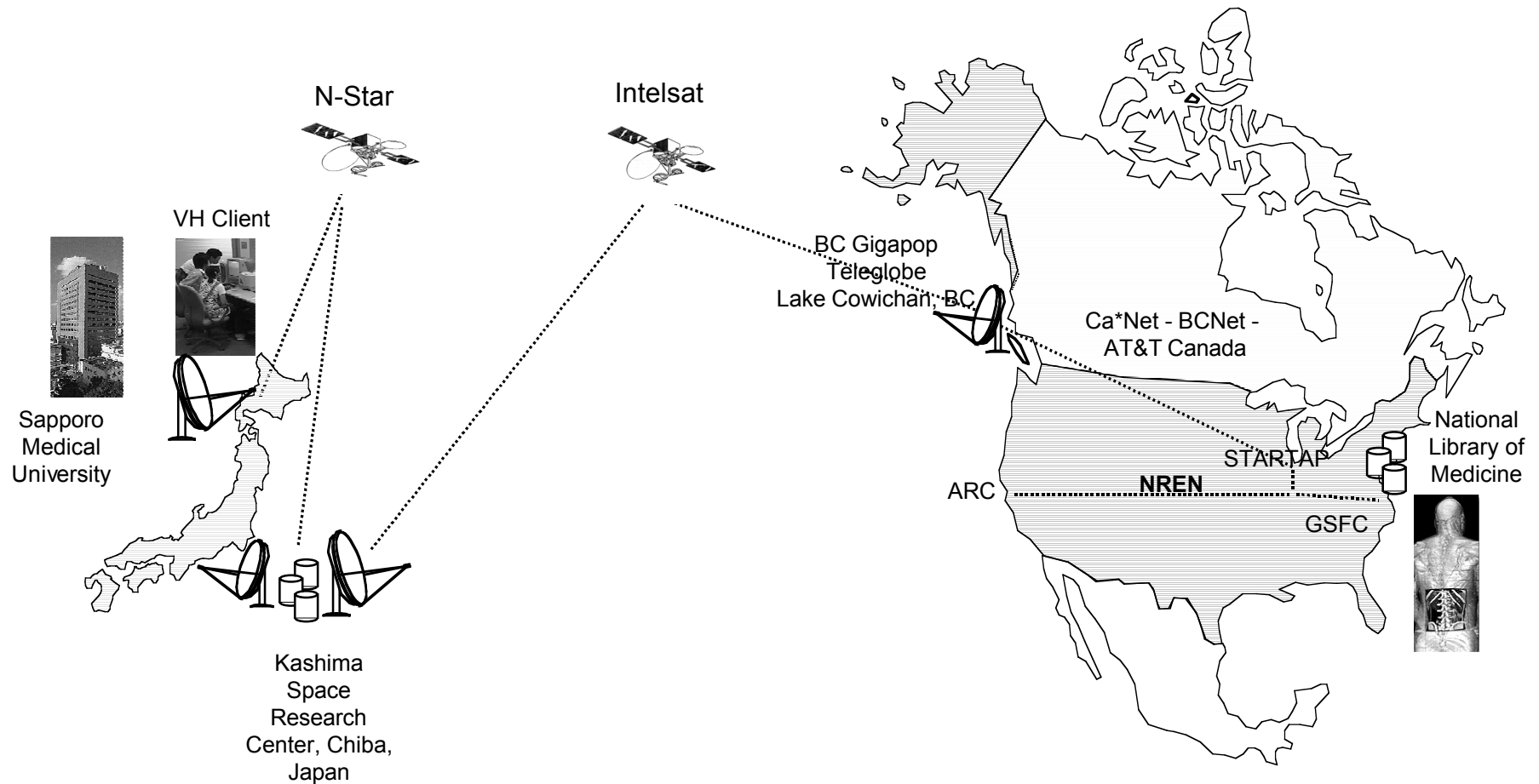


- **Visible Human**
 - **Purpose**
 - Access large image database services effectively over high speed computer networks from a distant location
 - Enable interactive biomedical image segmentation, labeling, classification and indexing to take place using large images
 - **Description**
 - Digital image library located at NLM in Maryland represents a complete, normal adult male and female cadaver
 - Centralized repository simplifies database management
 - Biomedical Image Collaboratory relies on the Visible Human Viewer application developed by Dr. Haruyuki Tatsumi of Sapporo Medical University
 - Visible Human data are transferred to and from the researcher via the high performance network infrastructure
 - Runs on a Macintosh computer

TPD Network Infrastructure



Trans-Pacific Demonstration Visible Human

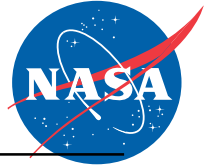


NASA RESEARCH AND EDUCATION NETWORK

Tomorrow's Networking Applications Today

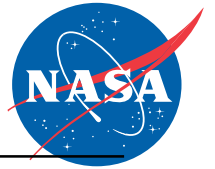


TPD Demonstrations

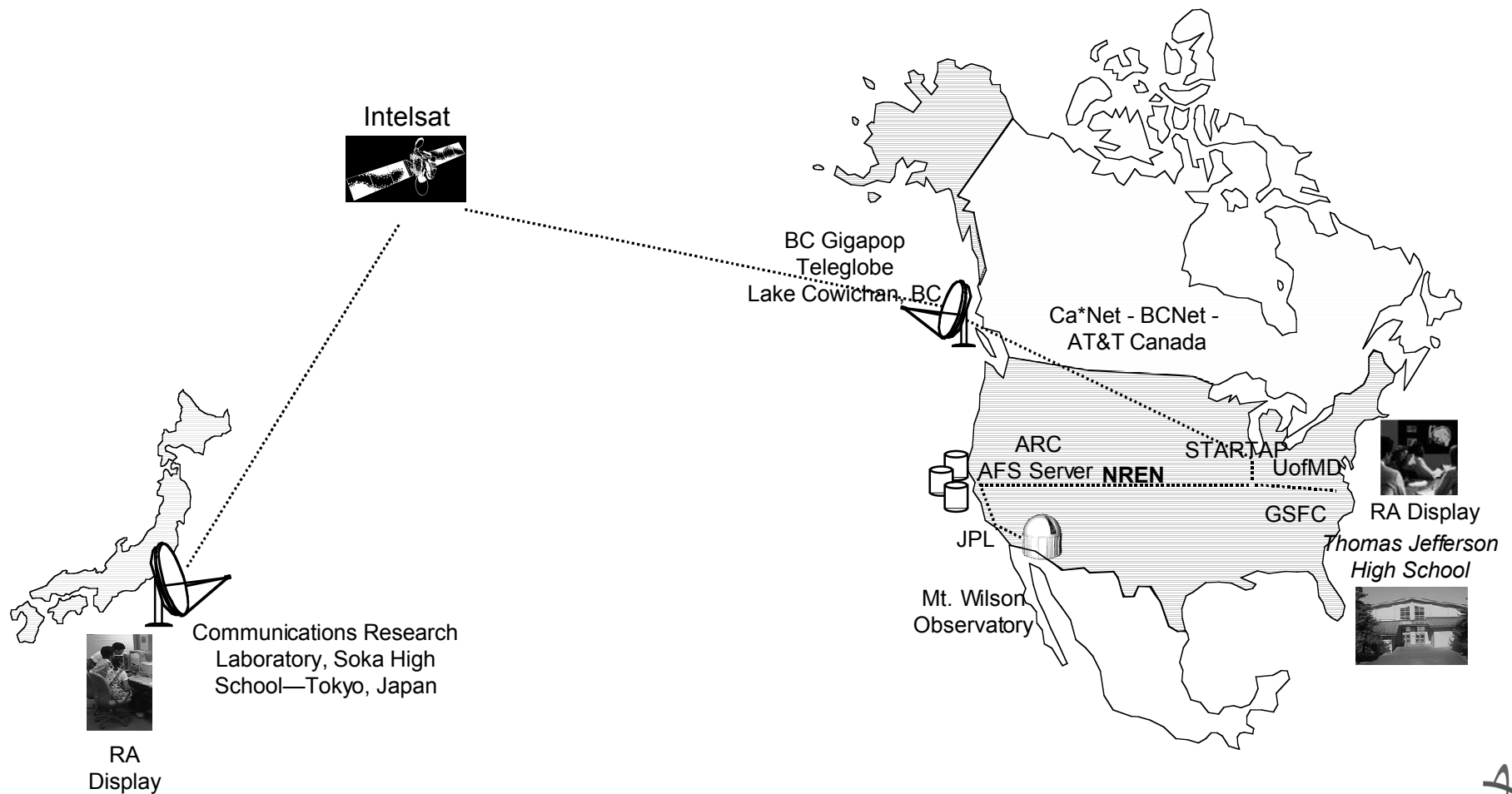


- **Remote Astronomy**
 - **Purpose**
 - Create a wide-area environment for distance learning and collaborative discussions and observations using IP multicast and distributed file system technologies
 - Establish a connection and permit the use of the Mt. Wilson telescope from remote locations
 - **Description**
 - A central distributed file system made possible wide area discussions and collaborations
 - The demo consisted of a collection of performance data and remote observation and control
 - Users included scientists and students in the US and Japan, including Soka High School in Tokyo and Thomas Jefferson High School in Maryland
 - Collected data are made available for later analysis and performance modeling by scientists and students around the world

TPD Network Infrastructure



Trans-Pacific Demonstration Remote Astronomy

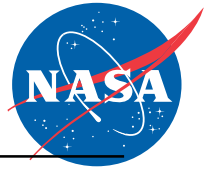


NASA RESEARCH AND EDUCATION NETWORK

Tomorrow's Networking Applications Today

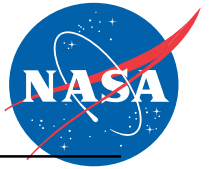


TPD Lessons Learned



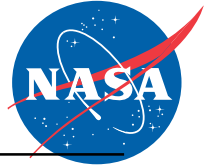
- **Communication**
 - Email and Web are essential for overcoming communication difficulties caused by different languages, time zones, and the International Date Line
 - Email delay removes chance for spontaneous interaction and its benefits
 - Need good critical path information management systems or tools
- **Coordination of Engineering and Operations**
 - Individual sites held weekly internal engineering/operations meetings
 - Weekly teleconferences helped coordinate parties at various sites
- **Time difference**
 - Adjusted hours of operation to accommodate personnel in different time zones
- **Need Permanent Access to Satellites for Demonstrations**
- **Difficult to Mix Commercial and Experimental Network Services**
- **Cooperative vs. Command Management**
 - Need “buy-in” from organizations and management
 - Need continuing “buy-in” for prototyping support from commercial vendor
 - Need dedicated systems engineering and integration support

Significance of Hybrid Networks



- **Significance**
 - Double satellite hops do not impede high performance data transfer, provided that IP implementations used are engineered and tuned for the high bandwidth-delay products involved
 - Remote medical consultation and diagnosis is feasible worldwide via satellite
 - Personal computers are usable for high performance scientific and medical applications
 - Delays caused by satellite hops do not interfere with serious educational use of astronomical telescopes
- **Implications for future hybrid networks**
 - The inherently ubiquitous nature of satellites and their ability to support multicast efficiently makes them suitable for supporting many high performance scientific and educational applications
 - The TPD experiments are a forerunner of many future applications that could use the same technologies and engineering lessons learned

TPD Points of Contact



- **Richard desJardins**, NASA Research and Education Network:
rdesjardins@mail.arc.nasa.gov
- **Ray Gilstrap**, NASA Research and Education Network:
rgilstrap@mail.arc.nasa.gov
- **Paul Lang**, NASA Goddard Space Flight Center:
lang@gi-joe.gsfc.nasa.gov
- **Naoto Kadowaki**, Communications Research Laboratory:
naoto@crl.go.jp
- **Eddie Hsu**, NASA Jet Propulsion Laboratory:
eddie.hsu@jpl.nasa.gov
- **Haruyuki Tatsumi**, Sapporo Medical University:
tatsumi@sapmed.ac.jp
- **Mike Gill**, National Library of Medicine:
gillm@mail.nlm.nih.gov
- **URL:** *<http://www.nren.nasa.gov/tpd/lessons>*